We claim:

1. A method of reducing pointing error ζ of a satellite transmit antenna, comprising the steps of:

with a satellite transmit antenna that has an estimated pointing attitude β, transmitting at least one pair of transmit beams that overlap in an overlap region wherein neither transmit beam covers the entire region covered by the other;

with at least one ground-based receiving terminal that has a known terminal location λ within said overlap region, measuring received signal strengths α of said transmit beams;

from said estimated pointing attitude β, said terminal location λ and said received signal strengths α, determining said pointing error ζ of said transmit beams; and

revising said pointing attitude β to reduce said pointing error ζ.

2. The method of claim 1, wherein said transmit beams comprise four transmit beams.

3. The method of claim 1, wherein said transmit beams comprise first and second transmit beams that are substantially aligned in a north-south direction and third and fourth transmit beams that are substantially aligned in an east-west direction.

4. The method of claim 1, wherein said determining step includes the steps of:

from said estimated pointing attitude β and said terminal location λ, providing predicted signal strengths; and

comparing said received signal strengths α and said predicted signal strengths to determine said pointing error ζ .

5. The method of claim 1, wherein said determining step includes the steps of:

resolving said pointing error ζ at an earth-based station; and

uplinking said pointing error ζ to said satellite.

6. The method of claim 1, wherein said determining step includes the steps of:

transmitting said signal strengths α to said satellite; and

resolving said pointing error ζ at said satellite.

7. The method of claim 1, wherein said revising step includes the step of altering the pointing attitude of said transmit antenna relative to said satellite.

8. The method of claim 1, wherein said revising step includes the step of altering transmit phases of elements of said transmit antenna.

9 The method of claim 1, wherein said revising step includes the step of altering the attitude of said satellite.

10. A method of reducing pointing error ζ of a satellite transmit antenna, comprising the steps of:

with a satellite transmit antenna that has an estimated pointing attitude β, transmitting at least three transmit beams that overlap in an overlap region where their gains are decreasing from their respective maximum gains;

with at least one ground-based receiving terminal that has a known terminal location λ within said overlap region, measuring received signal strengths α of said transmit beams;

from said estimated pointing attitude β, said terminal location λ and said received signal strengths α, determining said pointing error ζ of said transmit beams; and

revising said pointing attitude β to reduce said pointing error ζ.

11. The method of claim 10, wherein said transmit beams comprise four transmit beams.

12. The method of claim 10, wherein said transmit beams comprise first and second transmit beams that are substantially aligned in a north-south direction and third and fourth transmit beams that are substantially aligned in an east-west direction.

13. The method of claim 10, wherein said determining step includes the steps of:

from said estimated pointing attitude β and said terminal location λ, providing predicted signal strengths; and

comparing said received signal strengths α and said predicted signal strengths to determine said pointing error ζ.

14. The method of claim 10, wherein said determining step includes the steps of:

resolving said pointing error ζ at an earth-based station; and

uplinking said pointing error ζ to said satellite.

15. The method of claim 10, wherein said determining step includes the steps of:

transmitting said signal strengths α to said satellite; and

resolving said pointing error ζ at said satellite.

16. The method of claim 10, wherein said revising step includes the step of altering the pointing attitude of said transmit antenna relative to said satellite.

17. The method of claim 10, wherein said revising step includes the step of altering transmit phases of elements of said transmit antenna.

18. The method of claim 10, wherein said revising step includes the step of altering the attitude of said satellite.

19. A method of reducing pointing error ζ of a satellite receive antenna with transmit signals from ground-based transmitting terminals that have known terminal locations λ, the method comprising the steps of:

with a satellite receive antenna that has an estimated pointing attitude β, generating at least two receive beams that overlap in an overlap region where their gains are decreasing from their respective maximum gains and wherein said overlap

region contains at least one of said terminal locations λ;

measuring received signal strengths α from at least one of said transmitting terminals that are received through no more than two of said receive beams;

from said estimated pointing attitude β, said terminal locations λ and said received signal strengths α, determining said pointing error ζ of said receive antenna; and

revising said pointing attitude β to reduce said pointing error ζ.

20. The method of claim 19, wherein said receive beams comprise three receive beams.

21. The method of claim 19, wherein said receive beams comprise four receive beams.

22. The method of claim 19, wherein said receive beams comprise first and second receive beams that are substantially aligned in a north-south direction and third and fourth receive beams that are substantially aligned in an east-west direction.

23. The method of claim 19, wherein said determining step includes the steps of:

from said estimated pointing attitude β and said terminal location λ, generating predicted signal strengths; and

comparing said received signal strengths α and said predicted signal strengths to determine said pointing error ζ.

24. The method of claim 19, wherein said revising step includes the step of altering the attitude of said receive antenna relative to said satellite.

25. The method of claim 19, wherein said revising step includes the step of altering receive phases of elements of said receive antenna.

26. The method of claim 19, wherein said revising step includes the step of altering the attitude of said satellite.

27. A method of reducing pointing error ζ of a satellite transmit antenna, comprising the steps of:

with a satellite transmit antenna that has an estimated pointing attitude β, transmitting a set of transmit beams that have skirt regions where their gains decrease from their maximum gains wherein none of said transmit beams in said set of transmit beams has a coverage region including and greater than that of another of said transmit beams in said set of transmit beams;

with a set of ground-based receiving terminals that have terminal locations λ within said skirt regions, measuring received signal strengths α of said transmit beams wherein no more than two terminals in said set of ground-based receiving terminals measures said signal strengths α of any single transmit beam in said set of transmit beams;

based on said received signal strengths α from said set of ground-based receiving terminals, determining said pointing error ζ of said transmit antenna; and

revising said pointing attitude β to reduce said pointing error ζ.

28. The method of claim 27, wherein said receiving terminals comprise at least three receiving terminals.

29. The method of claim 27, wherein said receiving terminals comprise at least four receiving terminals.

30. The method of claim 27, wherein said determining step includes the steps of:

from said estimated pointing attitude β and said terminal locations λ, providing respective predicted signal strengths; and

comparing said received signal strengths α and said predicted signal strengths to determine said pointing error ζ.

31. The method of claim 27, wherein said determining step includes the steps of:

resolving said pointing error ζ at an earth-based station; and
uplinking said pointing error ζ to said satellite.

32. The method of claim 27, wherein said determining step includes the steps of:
transmitting said signal strengths α to said satellite; and
resolving said pointing error ζ at said satellite.

33. The method of claim 27, wherein said revising step includes the step of altering the pointing attitude of said transmit antenna relative to said satellite.

34. The method of claim 27, wherein said revising step includes the step of altering transmit phases of elements of said transmit antenna.

35. The method of claim 27, wherein said revising step includes the step of altering the attitude of said satellite.

36. A method of reducing pointing error ζ of a satellite receive antenna with transmit signals from ground-based transmitting terminals that have known terminal locations λ, the method comprising the steps of:
with a satellite receive antenna having an estimated pointing attitude β, generating at least one receive beam that has a skirt region where its gain is decreasing from its maximum gain wherein said skirt region includes said terminal locations λ;
measuring received signal strengths α that are received through said receive beam;
from said estimated pointing attitude β, said terminal locations λ and said received signal strengths α, determining said attitude.

37. The method of claim 36, wherein said transmitting terminals comprise at least four transmitting terminals.

38. The method of claim 36, wherein said determining step includes the steps of:

from said estimated pointing attitude β and said terminal locations λ, providing respective predicted signal strengths; and

comparing said received signal strengths α and said predicted signal strengths to determine said pointing error ζ.

39. The method of claim 36, wherein said revising step includes the step of altering the pointing attitude of said receive antenna relative to said satellite.

40. The method of claim 36, wherein said revising step includes the step of altering transmit phases of elements of said receive antenna.

41. The method of claim 36, wherein said revising step includes the step of altering the attitude of said satellite.

42. A method of acquiring attitude of a satellite, comprising the steps of:

with a satellite transmit antenna that has a pointing attitude β that is referenced to an arbitrarily selected starting reference frame, transmitting transmit beams that have different respective transmit parameters p_{tr} and are arranged with a known spatial relationship;

slewing said satellite in a search trajectory that sweeps said transmit beams over a ground-based receiving terminal wherein said receiving terminal has a known terminal location λ;

identifying received transmit beams from their received respective transmit parameters p_{tr}, their recorded received power, the time when the beams are identified, and the pointing attitude β at the time; and

from identified transmit beams, determining said satellite attitude from said pointing attitude β, said identification order and time of these beams, and recorded power measurements of

these beams.

43. The method of claim 42, wherein said transmit beams comprise at least three transmit beams.

44. The method of claim 42, wherein said transmit parameters p_{tr} are transmit frequencies.

45. The method of claim 42, wherein said transmit parameters p_{tr} are transmit modulations.

46. The method of claim 42, wherein said determining step includes the step of observing receive times of said transmit beams.

47. A method of acquiring attitude of a satellite, comprising the steps of:

from ground-based transmitting terminals that have known terminal locations λ, transmitting respective transmit signals that have respective transmit parameters p_{tr};

with a satellite receive antenna that has an estimated pointing attitude β that is referenced to an arbitrarily selected starting reference frame, forming receive beams;

slewing said satellite in a search trajectory that sweeps said receive beams with a search order over a selected transmitting terminal;

identifying said selected transmitting terminal from its respective received parameters p_{tr};

recording the received power, the time when the beams are identified and the pointing attitude at the time; and

determining said satellite attitude from the terminal location λ of said selected transmitting terminal and from said identification order, time, pointing attitude β, and received power.

48. The method of claim 47, wherein said receive beams comprise at least three receive beams.

49. The method of claim 47, wherein said transmit parameters p_{tr} are transmit frequencies.

50. The method of claim 47, wherein said transmit parameters p_{tr} are transmit modulations.

51. The method of claim 47, wherein said determining step includes the step of observing receive times of said transmit signals.